Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 1316-1319
Received: 07-01-2018
Accepted: 08-02-2018

Sangh Ravikiran
Ph.D. Scholar, Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

SS Angadi
Professor of Agronomy, Department of Agronomy College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Correspondence
Sangh Ravikiran
Ph.D. Scholar, Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka, India

Performance of soybean (*Glycine max* L.) with residual moisture and fertilizer resources under zero tillage conditions

Sangh Ravikiran and SS Angadi

Abstract
Field experiment was conducted consecutively over a period of two years at the Main Agricultural Research Station, Dharwad (Karnataka) to study the residual effect of moisture and fertilizer resources in soybean from preceding maize. The field experiment of maize was laid out in split-split plot design with three replications involving three main plots (irrigation levels) and six subplots (factorial combinations of fertilizer levels and time of fertilizers application) with 18 treatment combinations and one control outside the design. Residual effect of deficit irrigation at critical stages with hydrogel in preceding maize recorded significantly higher grain (11.2 q ha^{-1}) and haulm yield (1.7 t ha^{-1}) of soybean. Similarly, residual effect due to fertilizer levels of 250:100:125 kg $N:P_2O_5:K_2O$ ha^{-1} in preceding maize recorded significantly higher grain (12.5 q ha^{-1}) and haulm yield (1.8 t ha^{-1}) of soybean. Further, residual effect due to fertilizers application as 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS in preceding maize recorded significantly higher grain (11.8 q ha^{-1}) and haulm yield (1.7 t ha^{-1}) of soybean. Similarly, residual interaction effect of deficit irrigation at critical stages with hydrogel and fertilizer levels of 250:100:125 kg $N:P_2O_5:K_2O$ ha^{-1} when applied as 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS in preceding maize recorded significantly higher grain (14.5 q ha^{-1}) and haulm yield (2.0 t ha^{-1}) of soybean.

Keywords: irrigation, hydrogel, fertilizer, time of application and residual effect

Introduction
The need to feed the increasing population and increased use of fertile soil for non agriculture purpose, water scarcity, soil degradation, low soil fertility and yield stagnation, desires a paradigm shift through conservation principles and practices for water and nutrient resources to stabilize the yield. Minimum tillage in preceding crops with judicious method of water application and balanced fertilization improves soil health (balanced nutrient ratio and its need based fertilizer scheduling improves fertility) and soil moisture (increased rain water infiltration, water holding capacity and reduced evaporation loss) and efficiency varies greatly in succeeding crop. Utilization of such residual soil moisture and nutrient by growing short duration soybean crop reduces costs on farm input and increases farm productivity per unit area under zero tillage system. Information regarding such residual effects is meager under North Transitional Zone of Karnataka (Zone 8). Keeping above facts in view, present investigation was undertaken to analyze the water and fertilizer management practices in summer maize on performance of succeeding *Kharif* soybean.

Material and Methods
Water and fertilizer residual study was carried out in soybean (*Glycine max* L.) during *Kharif* season after harvesting preceding summer maize (*Zea mays* L.). Treatments in summer maize were irrigation levels (I_1 - deficit irrigation at critical stages, I_2 - I_1 with hydrogel at 1 kg ac^{-1} and I_3 - alternatively alternate furrow irrigation at 50 % depletion of soil moisture) in main plots, fertilizer levels (F_1; 200:75:75 kg $N:P_2O_5:K_2O$ ha^{-1} with 2.67:1:1 ratio, F_2; 225:100:100 kg $N:P_2O_5:K_2O$ ha^{-1} with 2.25:1:1 ratio and F_3; 250:100:125 kg $N:P_2O_5:K_2O$ ha^{-1} with 2.5:1:1.25 ratio) and time of fertilizers application (T_1 ; 1/4th of N, K_2O and 50 % of P_2O_5 as basal, 50 % of N, $P_2O_5$and K_2O at 30 DAS and 1/4th of N and K_2O at 50 DAS, and T_2 ; 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3 rd of N, P_2O_5 and K_2O at 50 DAS) in sub plots. Critical stages for deficit irrigation (I_1) as defined by Hanway (1963) [5]. Treatments were arranged in split-split plot design with three replications and one control outside the design (conventional irrigation with fertilizer levels of 150:75:37.5 kg $N:P_2O_5:K_2O$ ha^{-1} and application of fertilizers as 15 kg N plus full doses of P and K as basal, 30 Kg N at 20 DAS, 45 kg N each at 35 and 50 DAS and 15 kg N at 65 DAS). $MgSO_4$ (10 kg ha^{-1}) and

gypsum (250 kg ha^{-1}) were applied at sowing for all treatments except control. Experimental site was located at the Main Agricultural Research Station, Dharwad and trials were conducted during 2013-14 and 2014-15. Soil fertility estimation during summer season recorded the pH (7.4), EC (0.23 dS/m), available N (250 kg ha^{-1}), available P_2O_5 (33 kg ha^{-1}), available K_2O (290 kg ha^{-1}), exchangeable Ca (28 cmol (p+) kg^{-1}), exchangeable Mg (7 cmol (p+) kg^{-1}) and available S (21 kg ha^{-1}). Weeds in soybean were managed by pre plant application of herbicide (Round up @ 13 ml l^{-1} of water), pre emergence herbicide (Alachlor @ 4 ml l^{-1} of water) and post emergence herbicide (Imazethapyr @ 1 ml l^{-1} of water). *Rhizobium* treated soybean seeds were sown on 27th June in 2013 and 18th July in 2014 with 30 x 10 cm spacing. Gap filling and thinning were carried out to maintain optimum plant density. Need based plant protections were followed as per package of practices recommended for Northern Transition Zone of Karnataka (Zone 8). Harvesting of soybean was carried out on 17th September in 2013 and 8th October in 2014. Data were analyzed by scientific methods as suggested by Gomez and Gomez (1988).

Results and Discussion

Irrigation levels in preceding maize under minimum tillage recorded significantly higher residual effect on soybean under zero tillage with improved growth and yield parameters at harvest (Table 1). Deficit irrigation at critical stages with hydrogel polymer in preceding maize recorded significantly higher grain yield of soybean (11.2 q ha^{-1}) when compared to other management practices. Increased soybean yield might be due to increased 100 grain weight (23.3 g) under adequate moisture availability during reproductive stages which resulted in better translocation and partitioning of photosynthates. Besides, significantly higher haulm yield (1.7 t ha^{-1}) was recorded due to better synthesis and accumulation in vegetative and reproductive parts which reflected in higher total dry matter production (22.7 g). Increased dry matter is mainly because of higher moisture availability which helped in maintaining turgor pressure of cell thereby increasing intermodal length i.e., plant height (50.9 cm) and cell elongation i.e., leaf area (6.3 dm^2). Increased leaf area prolongs photosynthetic duration of leaf which ultimately increases crop growth rate (13.6 g m^{-2} day^{-1}). Similar research findings were reported by Ramakrishna *et al*. (1992) [8] with residual moisture. In contrast, control i.e., conventional furrow irrigation in preceding maize when compared with rest of the treatments combinations recorded significantly lower growth and yield parameters.

Fertilizer levels in preceding maize under minimum tillage revealed significant residual effect on soybean under zero tillage with improved growth and yield parameters at harvest (Table 1). Fertilizer levels of 250:100:125 kg N:P_2O_5:K_2O ha^{-1} in preceding maize recorded significantly higher residual response with increase in yield of soybean grain (12.5 q ha^{-1}) and haulm (1.8 t ha^{-1}) which is due to higher 100 seed weight (24.1 g). This clearly indicates that higher levels of fertilizer left substantial quantity of residues unsubjected for losses in summer season which might have been used for increasing seed weight. In addition, higher haulm yield might be due to better carbohydrate synthesis at vegetative and reproductive stages under adequate supply of nutrients, which resulted in increased total dry matter production (23.6 g). These observations are in agreement with the findings of Annadurai *et al*. (1994) [1] and Nasurudeen *et al*. (2000) [7]. Further, adequate nutrients in the soil resulted in higher cell division and expansion and significantly increased plant height (54.2 cm) and leaf area (6.4 dm^2) which reflected in higher crop growth rate (14.1 g m^{-2} day^{-1}). These observations are in agreement with the findings of Elamin and Madhavi (2015) [3] and Mc Andrews *et al*. (2006) [6]. Similarly, control i.e., fertilizer levels of 150:75:37.5 kg N:P_2O_5:K_2O ha^{-1} in preceding maize recorded significantly lower growth and yield parameters than the rest of the treatments. The results are in conformity of Duraisami and Mani (2001) [2].

Time of fertilizers application in preceding maize under minimum tillage revealed significant residual effect on soybean under zero tillage with improved growth and yield parameters at harvest (Table 1). Application of 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS in preceding maize, recorded significantly higher grain yield of soybean (11.8 q ha^{-1}) and 100 seed weight (22.8 g) when compared to other application of fertilizers. This is due to split application of fertilizers in preceding maize. The increase in yield and yield paramater were due to higher haulm yield (1.7 t ha^{-1}) which was due to higher photosynthatic assimilation in vegetative and reproductive parts and crop growth rate (13.1 g m^{-2} day^{-1}) resulted in significantly higher total dry matter production (22.3 g). Further, significantly higher plant height (51.5 cm) and leaf area (6.3 dm^2) were due to higher expansion of leaves which might have contributed for higher dry matter. Further, control i.e., application of 15 kg N plus full dose of P and K as basal, 30 Kg N (20 DAS), 45 kg N (each at 35 and 50 DAS) and 15 kg N (65 DAS) in preceding maize recorded significantly lower growth and yield parameters than the rest of the treatment combinations.

Interaction of irrigation levels, fertilizer levels and time of fertilizers application in preceding maize under minimum tillage revealed significant residual effect on soybean under zero tillage with improved growth and yield parameters at harvest (Table 1). In maize, deficit irrigation with hydrogel and fertilizers levels of 250:100:125 kg N:P_2O_5:K_2O ha^{-1} when applied as 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS recorded significantly higher yield of grain (14.5 q ha^{-1}) and 100 grain weight (27.4 g). This is due to efficient dry matter partitioning and better translocation to sink leading to formation of large sized grains and weight under adequate availablity of moisture and fertilizers. Further, higher haulm yield (2.0 t ha^{-1}) might be due to significant increase in crop growth rate (17.4g m^{-2} day^{-1}) during vegetative and reproductive stage accompanied by significantly higher total dry matter production (27.3 g). Higher dry matter might be due to higher cell division and elongation which resulted in higher plant height (61.0 cm) and leaf area (6.7 dm^2). These results are in line with the findings of Yague and Quilez (2014) [9] on growth and yield parameters under water and fertilizer management practices. In contrast, conventional furrow irrigation with fertilizers levels of 150:75:37.5 kg N:P_2O_5:K_2O ha^{-1} and application of 15 kg N plus full dose of P and K as basal, 30 Kg N (20 DAS), 45 kg N (each at 35 and 50 DAS) and 15 kg N (65 DAS) recorded lower growth and yield parameters.

Table 1: Growth and yield parameters of soybean at harvest (pooled data) with residual moisture and fertilizer resources under zero tillage conditions

		Plant height (cm)			Leaf area (dm^2)			Total dry matter production (g)			CGR at 45 DAS to harvest ($g\ m^{-2}\ day^{-1}$)			100 seed weight ($g\ plant^{-1}$)			Grain yield ($q\ ha^{-1}$)			Haulm yield ($t\ ha^{-1}$)		
		T_1	T_2	I × F	T_1	T_2	I × F	T_1	T_2	I × F	T_1	T_2	I × F	T_1	T_2	I × F	T_1	T_2	I × F	T_1	T_2	I × F
		I × F × T			I × F × T			I × F × T			I × F × T			I × F × T			I × F × T			I × F × T		
I_1	F_1	40.5gh	44.0e-g	42.2d	5.7j	6.0gh	5.9d	16.5jk	18.6i	17.5f	8.5h-j	10.3f-h	9.4d	18.0i	20.2h	19.1e	7.7f-h	10.0de	8.8d	1.4ef	1.6d-f	1.5bc
	F_2	45.8d-f	53.4b	49.6b	6.0gh	6.5cd	6.2bc	20.6gh	24.4b-d	22.5cd	11.8d-f	14.8bc	13.3bc	21.7fg	23.7de	22.7c	10.9cd	12.9bc	11.9bc	1.7b-d	1.9ab	1.8a
	F_3	48.6cd	61.1a	54.9a	6.3de	6.6ab	6.5a	22.1e-g	25.8ab	23.9b	12.9c-e	15.8ab	14.4b	22.9ef	26.1b	24.5b	11.7cd	15.0a	13.4a	1.8a-c	2.0a	1.9a
I_2	F_1	42.5fg	45.9d-f	44.2cd	5.7j	6.0gh	5.9d	18.0ij	19.7hi	18.8ef	9.9f-h	11.3e-g	10.6d	18.7i	20.9gh	19.8e	7.5gh	10.0de	8.7d	1.3fg	1.6d-f	1.5c
	F_2	49.1cd	54.4b	51.7b	6.2ef	6.5bc	6.3b	22.3e-g	25.3a-c	23.8bc	13.4cd	15.6ab	14.5b	22.8ef	25.1bc	23.9b	10.5de	12.9bc	11.7c	1.7b-d	1.9ab	1.8a
	F_3	52.5bc	61.0a	56.7a	6.4cd	6.7a	6.6a	23.6c-e	27.3a	25.4a	14.4bc	17.4a	15.9a	24.7cd	27.4a	26.0a	11.7cd	14.5ab	13.1ab	1.8a-c	2.0a	1.9a
I_3	F_1	36.5h	40.4gh	38.4e	5.4k	5.8ij	5.6e	14.5k	15.8k	15.1g	6.7j	7.8ij	7.2e	16.4j	17.6ij	17.0f	6.0h	7.8f-h	6.9e	1.1g	1.3fg	1.2d
	F_2	44.1e-g	49.2cd	46.7c	5.9hi	6.2ef	6.1c	17.8ij	21.1f-h	19.5e	9.3g-i	11.8d-f	10.6d	18.7i	21.3gh	20.0e	8.6e-g	10.6de	9.6d	1.4ef	1.6c-e	1.5bc
	F_3	47.6de	54.3b	51.0b	6.1fg	6.4cd	6.3bc	19.8hi	22.9d-f	21.3d	11.0e-g	13.3cd	12.1c	20.8gh	22.7ef	21.8d	9.6d-f	12.6bc	11.1c	1.5d-f	1.7b-d	1.6b
		T_1	T_2	I	T_1	T_2	I	T_1	T_2	I	T_1	T_2	I	T_1	T_2	I	T_1	T_2	I	T_1	T_2	I
		I × T					I × T	I × T			I × T						I × T			I × T		
	I_1	44.9c	52.9a	48.9ab	6.0b	6.4a	6.2ab	19.7d	22.9b	21.3a	11.1d	13.6b	12.4ab	20.9d	23.3b	22.1a	10.1b	12.6a	11.4a	1.6b	1.8a	1.7a
	I_2	48.0b	53.8a	50.9a	6.1b	6.4a	6.3a	21.3c	24.1a	22.7a	12.5c	14.7a	13.6a	22.1c	24.5a	23.3a	9.9b	12.5a	11.2a	1.6b	1.8a	1.7a
	I_3	42.7c	48.0b	45.3b	5.8c	6.1b	6.0b	17.4e	19.9d	18.6b	9.0e	10.9d	10.0b	18.6e	20.6d	19.6b	8.1c	10.3b	9.2b	1.4c	1.6b	1.5b
		T_1	T_2	F	T_1	T_2	F	T_1	T_2	F	T_1	T_2	F	T_1	T_2	F	T_1	T_2	F	T_1	T_2	F
		F × T					F × T	F × T			F × T						F × T			F × T		
	F_1	39.8f	43.4e	41.6c	5.6e	6.0d	5.8c	16.3f	18.0e	17.2c	8.3f	9.8e	9.1c	17.7e	19.6d	18.6c	7.1e	9.3d	8.2c	1.3e	1.5d	1.4c
	F_2	46.3d	52.4b	49.3b	6.0d	6.4b	6.2b	20.3d	23.6b	21.9b	11.5d	14.1b	12.8b	21.1c	23.4b	22.2b	10.0cd	12.1b	11.1b	1.6cd	1.8ab	1.7b
	F_3	49.6c	58.8a	54.2a	6.3c	6.6a	6.4a	21.8c	25.3a	23.6a	12.8c	15.5a	14.1a	22.8b	25.4a	24.1a	11.0c	14.0a	12.5a	1.7bc	1.9a	1.8a
	T	45.2b	51.5a		6.0a	6.3b		19.5b	22.3a		10.9b	13.1a		20.5b	22.8a		9.4b	11.8a		1.5b	1.7a	
Control		36.7			4.3			18.3			11.7			17.8			3.7			1.0		
Comp. of means		S.Em.±			S.Em.±			S.Em.±			S.Em.±			S.Em.±			S.Em.±			S.Em.±		
I		1.19			0.07			0.68			0.65			0.32			0.29			0.04		
F		0.56			0.03			0.26			0.26			0.17			0.26			0.03		
T		0.46			0.02			0.21			0.21			0.14			0.21			0.02		
I × F		0.97			0.05			0.45			0.44			0.30			0.45			0.05		
I × T		0.79			0.04			0.37			0.36			0.25			0.37			0.04		
F × T		0.79			0.04			0.37			0.36			0.25			0.37			0.04		
I × F × T		1.37			0.07			0.64			0.63			0.43			0.64			0.07		
Cont. v/s treats.		1.59			0.09			0.82			0.80			0.51			0.65			0.08		

Irrigation levels (I) :

I_1 - Deficit irrigation (critical stages)

I_2 - I_1 + hydrogel (1 kg ac^{-1})

I_3 - Alternatively alternate furrow irrigation (50 % depletion of soil moisture)

Fertilizer levels (F) :

F_1 - 200:75:75 kg N:P_2O_5:K_2O ha^{-1} (2.67:1:1)

F_2 - 225:100:100 kg N:P_2O_5:K_2O ha^{-1} (2.25:1:1)

F_3 - 250:100:125 kg N:P_2O_5:K_2O ha^{-1} (2.5:1:1.25)

Time of application (T) :

T_1 - 1/4th of N, K_2O and 50 % of P_2O_5 as basal, 50 % of N, P_2O_5 and K_2O at 30 DAS and 1/4th of N and K_2O at 50 DAS

T_2 - 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS

DAS - Days after sowing, Means followed by same letter did not differ significantly by DMRT (p = 0.05)

Control : Conventional furrow irrigation with 150:75:37.5 kg N:P_2O_5:K_2O ha^{-1} (4:2:1) scheduled as 15 kg N plus full dose of P and K as basal, 30 Kg N (20 DAS), 45 kg N (each at 35 and 50 DAS) and 15 kg N (65 DAS)

Conclusion

In maize, deficit irrigation at critical stages with hydrogel, fertilizer levels of 250:100:125 kg $N:P_2O_5:K_2O$ ha^{-1}, application of fertilizers as 1/3rd of N, P_2O_5 and K_2O as basal, 1/3rd of N, P_2O_5 and K_2O at 30 DAS and 1/3rd of N, P_2O_5 and K_2O at 50 DAS and its interaction proved superior on growth and yield parameters in succeeding soybean and to realize full yield potentiality of soybean.

References

1. Annadurai K, Seshadri P, Palaniappan S. Response of soybean (*Glycine max* L.) to phosphorus and residual potassium. Indian Journal of Agronomy, 1994; 39(2):320-322.
2. Duraisami UP, Mani AK. Effect of inorganic nitrogen, coir pith and biofertilizer on availability and uptake of phosphorus and potassium under maize preceded (*Zea mays* L.) with sole and intercropped sorghum (*Sorghum bicolor* L.). Madras Agricultural Journal. 2001; 87(10-12):655-659.
3. Elamin AY, Madhavi K. Residual effect of integrated nutrient management on growth and yield parameters of rabi chickpea (*Cicer arietinum* L.) under cropping system. American Journal of Scientific and Industrial Research. 2015; 6(5):103-109.
4. Gomez KA, Gomez AA. Statistical Procedure for Agricultural Research. John Wiley and Sons, New York, 1984, pp. 130-271.
5. Hanway JJ. Growth stages of corn (*Zea mays* L.). Agronomy Journal. 1963; 55(5):487-492.
6. Mc Andrews GM, Liebman M, Cambardella CA, Richard TL. Residual effects of composted and fresh solid swine (*Sus scrofa* L.) manure on soybean (*Glycine max* L.) growth and yield. Agronomy Journal. 2006; 98(4):873-882.
7. Nasurudeen P, Chellamuthu S, Subramanian SR. Fertilizer nutrients carry over impacts in irrigated groundnut (*Arachis hypogaea* L.) production. Journal of Indian Society of Soil Science. 2000; 48(2):263-267.
8. Ramakrishna A, Anders MM, Flower DJ. Managing AGLN crops in rice-based cropping systems. Summary Proceedings of the Myanmar-AGLN/ICRISAT Workshop and Monitoring Tour, 17-25 January 1992, International Crops Research Institute for the Semiarid Tropics, Patancheru, Andhra Pradesh, India. 1992, pp: 55-58.
9. Yague MR, Quilez D. Pig slurry residual effects on maize yields and nitrate leaching: a study in lysimeters. Agronomy Journal. 2014; 107(1):278-286.